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Flashings for Membrane Roofing

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Successful flat roof systems and roofing membranes are usually possible if building science principles are understood and applied to design and construction. Difficulties occur, however, when the designer fails to appreciate the necessity to detail the complete waterproofing system. The details of interruptions and terminations of the membrane at ancillary features are of such particular importance that their selection and manner of construction should not be left to the discretion of a material supplier or a tradesman at the job site.

In Canada, as in most other countries, faulty flashings at interruptions and terminations of roofing membranes are a frequent source of roof leakage. It is clearly a design function to study the exterior surfaces of a proposed building to determine the location, materials to be used, and the details of installation for all flashings. A clear understanding of the function of flashings, the forces to which they are subjected, and the limitations of the materials commonly used, is necessary for successful design. This Digest describes flashings for flat roofing and some of the required ancillary building details.

Function of Flashings

A flashing is a building device used to prevent water from penetrating the exterior surface of a building element or to intercept and lead water out of it. Several types of flashing are used at terminations and interruptions of roofing membranes, some capable of holding and others of shedding water. The complete roofing membrane might be considered a large flashing designed to hold water while it flows slowly to the drainage system. When ancillary building elements penetrate or intersect the roof and rise above it, one method of maintaining the water-holding capacity of the membrane is to turn it up around the element. This turned-up continuation of the roofing membrane is a base flashing, and is usually applied in a separate operation.

Penetrating or intersecting building elements can be expected to move in relation to the roof. It is difficult to predetermine the magnitude and nature of these differential movements, but it is entirely necessary that they be considered in the design of the flashing detail. If connected to the element, the base flashing must be capable of bridging any cracks that may form and of withstanding differential movements. Materials commonly used for flashings are not capable of providing a reasonable service life under those conditions, however, and it is wise to make some other provision for movement. The base flashing can be kept free of the penetrating or intersecting element and given separate support attached to the roof.

The top of the base flashing and the space between the base flashing support and the penetrating or intersecting element are exposed to weather penetration and must be protected by a flashing to shed water. This is a counter flashing, which is attached to the penetrating or intersecting element and overlaps it but is free of the base flashing. Base and counter flashings are illustrated in Figure 1; they are the two basic flashings used in detailing junctions between roofing and ancillary building elements.

Variations of the basic roof flashings are necessary in relation to roof eaves, and certain wall flashings are required to tie in with the roof flashings when walls extend above the roof plane. It is not possible in this Digest to list all cases where special attention to detail is required, but representative cases are pre-

sented that illustrate the use of basic flashings and some special installations.

Small Projecting Elements

Careful consideration should be given in the design of a building to limiting the number of penetrations through a roof. If mechanical equipment must be placed above the roof, structural platforms should be detailed for it to stand on. Where there is no alternative to carrying structural members through the roof, where it is necessary to provide structural anchors for equipment mounted on the roof, or where pipes and ducts penetrate, it becomes necessary to detail and apply flashings according to the principles already explained.

On very small pipes, ducts or other projecting elements the separate support for the base flashing is often not used. Instead, metal or plastic flanged sleeves attached to the roofing at the flanges take their place. These are usually satisfactory, but they may require frequent maintenance. A flanged sheet metal support surrounding the penetrating item can be used to carry the base flashing up around it. Counter flashing can be provided by a cover attached to the penetrating item. In practice the support is referred to as a pan, because it is usually filled with soft bitumen. The detail, if properly made, can perform satisfactorily without bitumen, but it is customary and desirable to use weather-sloped mastic filling as a secondary deterrent to water penetration. The detail is illustrated schematically in Figure 2.

Intersecting Wall Flashings

Walls rise above the surface of the roof at penthouses, skylights, chimneys, equipment housings, parapets and similar building features. Base and counter flashings are used at all such walls according to the principles already described. In addition, some walls require flashings selected in relation to the wall design. It is important that such wall flashings be tied in with the roof flashings if a successful junction of roof and wall is to be achieved.

Experience from field investigations indicates that many apparent roof leaks can be traced to faulty wall flashings. The designer will be aware of the means necessary to control rain penetration of walls (CBD 40), and where partial or through penetration is possible through-wall flashings have to be provided to lead water out of the wall. Because they are exposed to extremes of weathering on both sides and top, parapet walls extending above the roof will usually be subjected to the most severe weathering.

The joints for copings of preformed units frequently used at the top of parapet walls are vulnerable to rain leakage. To prevent water

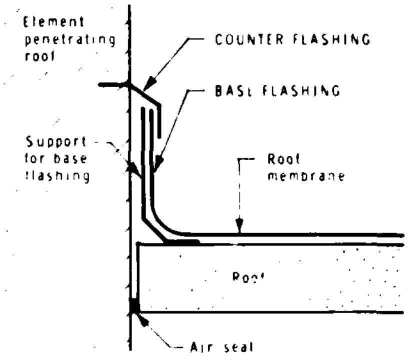

Figure 1 Basic flashings

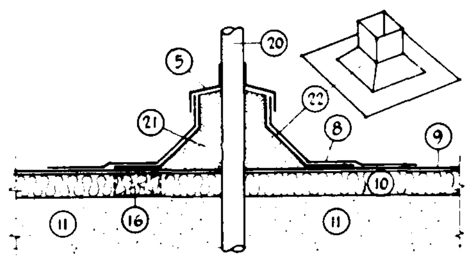

Figure 2 Projections through the roof

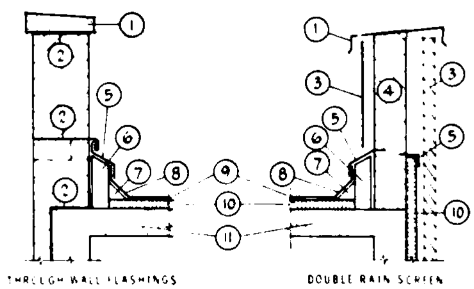

Figure 3 Parapet walls

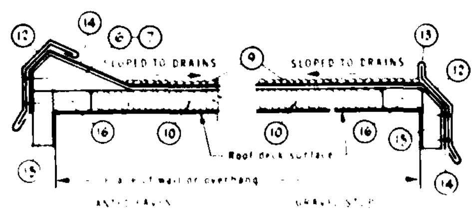

Figure 4 Finish at roof eaves

DRAWING LEGEND

(1) COPING
(2) THROUGH WALL FLASHING
(3) RAIN SCREEN
(4) STRUCTURAL AIR TIGHT WALL
(5) COUNTER FLASHING
(6) CURB
(7) CANT
(8) BASE FLASHING
(9) BUILT-UP MEMBRANE
(10) INSULATION
(11) ROOF DECK
(12) EAVES FLASHING AND DRIP
(13) GRAVEL STOP
(14) MEMBRANE EAVES FLASHING
(15) FASCIA
(16) BLOCKING WHERE NECESSARY
(17) FLEXIBLE MEMBRANE
(18) AIR AND VAPOUR BARRIER
(19) LOOSE LOCK OR DOUBLE LOCK JOINT
(20) ROOF PENETRATION (PIPE, BOLT, ETC)
(21) BITUMINOUS MASTIC
(22) BOTTOMLESS FLANGED METAL RETAINER

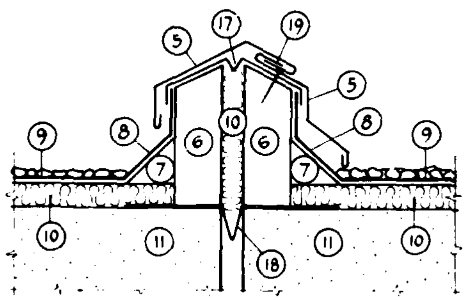

Figure 5 Movement joint

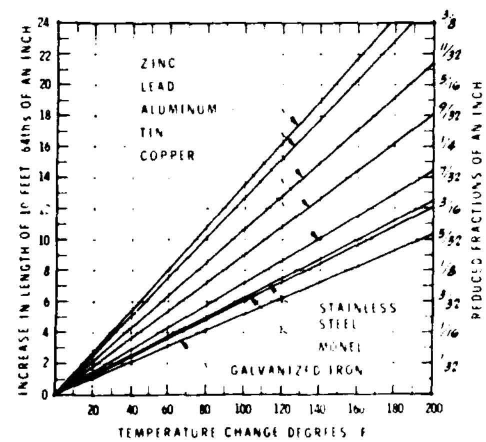

Figure 6 Thermal movement for 10-foot lengths of commonly used flashing metals

penetration into the walls it is necessary to use a through-wall flashing immediately under the coping, although this can be avoided if the coping is designed as a counter flashing to shed water, allow for expansion and contraction, and keep water out at the joints. Caulking compound cannot be depended on to keep joints watertight, because hardening and movement soon crack it open.

Water that penetrates the top of the parapet wall or the wall surfaces will flow downward under the influence of gravity; and unless it is led out of the wall before reaching vulnerable areas it can penetrate the roofing system. A *through-wall flashing overlapping* the counter flashing will accomplish this. Through-wall flashings at the roof slab edge or spandrel beam may also be required, depending on the wall and roof details as indicated in Figure 3.

A parapet wall employing open rain screen principles for the design of the exterior cladding (CBD 40) is also indicated schematically in Figure 3. The parapet in this case becomes a double rain screen wall. This means a wall in three parts. The centre portion is structural and must be air-tight so that pressure equalization can be achieved across the rain screen on each side of it. It may be observed that the metal wall covering frequently used on the roof side of the parapet can act as the rain screen if a ventilated air space is provided behind it, according to open rain screen principles.

Perimeter Eaves Flashing

Many architects have eliminated parapet walls from their architectural planning, and all *walls of their buildings are covered by the* main roof. This can simplify the perimeter flashing details, since in the simplest form the membrane can be turned down over the eaves to shed water and no counter flashing is required. In practice, the eaves detail is complicated by other requirements such as the need to prevent water, bitumen or roof surfacing materials from spilling over the eaves. The designer will usually also want a neater architectural finish than that provided by the edge of the roof flashing. This can be provided with reasonable certainty of freedom from trouble if proper detailing is carried out according to the principles indicated in Figure 4. Using this sort of detail the drip edge, gravel stop, architectural finish, or combination as required, is kept free of the roof membrane and eaves flashing. This allows completion of the roof membrane before it is necessary to apply the finish flashing, and allows as well for movement of the flashing due to temperature changes separate from that of the roof membrane.

Movement Joint Flashing

Movement joints are devices or details designed to allow for movement in adjacent parts of a building system resulting from expansion and contraction due principally to changes in temperature. Movement joints are deliberate discontinuities in the system where adjacent parts are separated and a covering designed to allow movement is provided to keep water out of the separation. Treatments that provide for movement by a fold in the roofing membrane are not always completely successful because they are vulnerable to damage and deterioration. The most satisfactory detail is thought to be one where adjacent edges of the separated membrane are turned up against supports that move integrally with the portion of the system to which they are attached. The supports must be detailed so that they do not constitute thermal bridges (CBD 44). Base flashings and counter flashings are provided, as is indicated in Figure 5. Such upstanding supports are easily handled architecturally when there are parapet walls, but may present a challenge to the designer for roofs with overhanging eaves.

Selection of Flashing Material

A similar amount of labour is involved for the installation of all the commonly used flashing materials, and repair of leaking and deteriorated flashings can be expensive. For this reason first cost of material should not greatly influence the choice. Selection should be made on the basis of suitability to the particular application and exposure. Flashings should have a service life at least equal to the assemblies into which they are built. Flashing materials include bituminous felts, glass fibre fabrics, a variety of metals, and newer materials such as vinyl, neoprene and butyl rubber.

Base flashings are required to be flexible for moulding to the supports, compatible with the roofing membrane, resistant to sagging and slipping, and highly resistant to weather. Bituminous felts are the usual choice for use with bituminous roofing because of compatibility, but they are not sag resistant and there is danger of bitumen flow and slippage in hot weather. Flashings formed by the use of open-weave glass fibre fabric embedded in and surfaced with a bitumen emulsion are light in weight and answer all the requirements of the base flashing. Where application limitations due to temperature and weather pose a problem, bituminous mastic can in some cases be used as a substitute for emulsion. The flashing bitumen must, however, be compatible with the bitumen used for the roofing membrane.

Vinyl, neoprene, butyl rubber and such new flashing materials were developed for special applications in relation to corrugated and other overlapping type roofing materials. Although not initially intended to replace conventional bituminous flashings, they are receiving considerable use as base flashings. Flexibility, ease of moulding, and application in one ply are known advantages, but adequate field performance history is not yet available on most types. Resistance to cracking from brittleness in cold weather, deterioration from ozone and sunlight, and compatibility with other roofing materials are the main factors requiring consideration.

Metals are not suitable as base flashings because they are generally too rigid and difficult to bond to membrane materials. Expansion and contraction characteristics as indicated in Figure 6 also tend to separate them from roofing materials. The rigidity of metal is generally an advantage for use as counter flashing and eaves flashing, where the material is required to hold its shape. Galvanized iron, copper, and aluminum are the usual choices, with lead, zinc, terne, monel and stainless steel used to some extent. Vulnerability to atmospheric pollution, staining of contiguous materials from water wash, and expansion and contraction characteristics are some of the factors governing the choice of metal.

The usual choice for through-wall flashing is metal or metal foil bonded to fabric, asphalt, or paper. Metal should be deformed or ribbed, or applied in a stepped manner to achieve better bond in masonry walls.

Summary

Examples have been given of the principles to follow in the design of roof flashings. It has been recommended that base flashings are to be kept free of items penetrating a roof; that metal counter flashings are to be separated from the roofing membrane; and that metal counter flashings are to shed water and be free to move at end joints to prevent buckling or breaking. The flashings, of course, cannot be divorced from the over-all design of the building wall and roof systems. The roof, for instance, must be sloped to provide drainage, and the walls designed to control rain penetration. Because of this, all details of the complete water control system should be worked out by the building designer.

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